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Composted versus stockpiled manure; different processes...totally different results

Livestock producers striving to develop sustainable and environmentally sound systems for handling manure need to know the difference between stockpiling manure and composting.

Transforming manure into a non-offensive, nutrient rich, highly organic material known as compost doesn't happen by accident.

Piling manure for a year, or even 10 years, does not produce compost, says Virginia Nelson, an agricultural engineer-in-training and composting researcher at the AgTech Centre in Lethbridge. "Some producers seem to be confused about the two systems," she says "They believe as long as manure sits for a while, it becomes compost."

But it doesn't. It simply becomes older, usually drier manure, that still carries some of the same features of raw manure. "Because the pile eventually dries out, you end up with 'de-watered' or 'de-volumed' manure," says Nelson. "There is less of it – but it is still manure. If the material becomes wet again, or if you hit pockets that haven't dried out, the odour can be just as great and most times worse than raw manure."

Two different processes

To understand compost, producers need to be clear on the processes at work.

Compost is defined as the controlled aerobic decomposition of manure (or other nitrogen source), which produces a stable organic material. Oxygen is a key element in the process, and when combined with a good carbon source, nitrogen and moisture, produces the proper high temperature environment for microbial activity. These microbes digest and process the various components of manure, rendering it less offensive, and in many respects, less harmful to the environment. At the same time, the process maintains many of the nutrient quality characteristics of manure.

Ideally, manure to be composted needs a carbon source such as straw or woodchips to produce a carbon-to-nitrogen ratio of 25:1. Composting works best at about 55 percent moisture content. Temperatures inside the compost should range between 40 and 60 C.

Stockpiled manure, on the other hand, is just that - manure that is piled. It decomposes slowly in an anerobic state that is, the absence of oxygen. A different set of microbes are at work in this environment and they produce different results. "While stockpiled manure still has much of the nutrient quality of raw manure, it also retains much of the volume, odour, and bacteria and weed seed issues often associated with raw manure," says Nelson.

Two different products

Properly composted manure produces a highly organic material with a non-offensive odour, that is free of both

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weed seeds and harmful pathogens such as salmonella and E-coli bacteria. Heat during the composting process destroys seeds and most harmful bacteria. Manure volume, reduced by about 60 percent, results in less material to be handled or spread on fields. The high organic quality of the compost holds water well, which improves overall soil moisture content.

Some research shows straw-based compost supplies 18 percent more available nitrogen than straw manure on a wet weight basis. Overall, 25 to 35 percent of nitrogen is lost in the composting process. The Olds College Compost Technology Centre compost analysis data bank reports nutrients in raw and composted cattle manure contained 1.22 percent nitrogen, and 1.06 percent nitrogen, respectively. While these figures vary depending on source of the product and the composting process, raw manure will usually have higher nitrogen values.

Like compost, stockpiled manure adds both organic matter and nutrients to the soil.

However, stockpiled manure has significant drawbacks. It has a persistent strong odour when spread, weed seeds can survive for a considerable time, and pathogens can thrive. The weed seeds can germinate after land application, and pathogens and nutrients can leach into surface and groundwater.

Most organic material can be composted

Composting works with a surprisingly wide range of "waste" agricultural materials, but it's a technique that may not suit every operation, says Nelson.

While manure composting is the most familiar composting process, other "agricultural wastes" also lend themselves to the technique. Research is looking at economical and effective ways to compost both planned and unexpected cases of livestock mortality.

"We're finding composting can also be used to dispose of livestock mortality as an alternative to shipping dead animals for rendering, burial or incineration," says Nelson.

Manure volume, land base are factors

Livestock producers need to assess their individual manure handling capabilities.

Feedlots that have an adequate land base readily available for raw manure disposal might find composting just an added cost.

"However for those operations without sufficient land base for manure disposal, or that need to truck manure an appreciable distance, composting may be a viable option," she says. "This could represent a considerable savings in trucking costs since composting reduces raw manure volume by as much as 60 percent."

Composting may also not be worthwhile to cow/calf producers who don't deal with high manure volumes. On the other hand, it may make good sense for the smaller land base dairy, hog, poultry and other intensive livestock operations, which produce large manure volumes and want to reduce manure-hauling costs. The operation's proximity to urban centres and consequent odour issues is also a prime concern.

"Some hog producers with dry manure production systems compost manure and sell the composted product," says Nelson. "And in some cases producers have delivered compost to a central location in a community where home gardeners can help themselves. It's a good product and it's a goodwill gesture that helps maintain positive community relations."

Cost and time are key issues

Even with basic windrow composting, time and cost are cited as two drawbacks, says Nelson. Composting materials, manure and straw for example, are assembled in a windrow where they are digested by microbes. The whole process takes several weeks. There is no set specification on windrow size, but typically it might range from a base of eight to 15 feet wide, stand from four to seven feet high, and stretch 20 to 30 feet long. Ideally, properly composted manure should be turned once or twice per week during the process to introduce more oxygen, add moisture and maintain temperatures.

Livestock mortality compost lends itself to being turned by a standard farm tractor equipped with a front-end loader. However, as a general rule, for best results manure compost should be turned with a specially designed windrow turner, points out Nelson.

Typically, drum-style turners are used to turn the windrow and break up large clumps of manure, producing a uniform particle size that composts more readily and is easier to apply to the land. The turners come in a wide range of sizes and costs; price increases depend on size and type of equipment. The selection depends on the operation's manure volume. The smaller three-point hitch models start around $15,000, while large self-propelled units cost around $250,000. While figures will vary with each operation, AgTech Centre research shows it costs about $8.46 per tonne to produce compost from feedlot manure. That cost includes the use of a 120 horsepower tractor equipped with a tow-behind windrow turner used for about 400 hours per year.

"The bottom line is the value of composting depends on each individual operation," says Nelson. "Is the manure volume large enough? Is there a less expensive way to properly handle manure? Is there an opportunity to produce a value-added agricultural product with commercial value? These are some of the questions producers need to ask."

New composting options on the horizon

Emerging technology may soon offer new solutions to livestock producers for improved composting techniques of manure and other so-called waste materials.

While the basic concept of composting – turning organic material into humus – has been referenced historically for several thousand years, the practical systems for today's Prairie farmers are based on relatively new technology.

The AgTech Centre strives to answer the key question posed by livestock producers - what are the practical solutions to waste handling and management? With compost research, for example, techniques used in other parts of the world can be adapted to help producers turn so-called waste into more manageable, valuable end products.

Leading edge of technology

AgTech Centre is heavily involved in leading edge composting technology, evaluating both equipment and processes in a broad range of agricultural operations.

Recent and ongoing projects clearly illustrate the broad scope of research:

- Windrow composting of livestock manure.
- Effects of moisture on composting windrows.
- Use of a "compost tea" to inoculate compost windrows with microbes.
- Bin-style composting techniques.
- Compost quality issues as they relate to guidelines in Alberta's Agricultural Operations Practices Act (AOPA).
- Windrow composting for livestock mortality including spent hens, swine and cattle.
- Evaluation of equipment designed for turning composting windrows.
- The role of composting in controlling livestock industry odours.
- Compost nutrient levels in cropping systems.

A team effort

Composting is a big subject with many unanswered questions. Alberta's AgTech Centre specialists are part of a research network within government and educational institutions looking at the details of composting technology.

"It's a co-operative effort," explains Virginia Nelson, an agricultural engineer-in-training and compost researcher at the AgTech Centre. "Where possible, we share facilities as well as our knowledge base and experience."

AgTech Centre specialists, for example, work closely with Agriculture and Agri-Food Canada researchers at the Lethbridge Research Centre and other centres.

Their projects have looked at aspects of composting beef feedlot manure. Research includes: the effects of different types of livestock bedding material – straw and woodchips – on the composting process; and the value of composted manure in improving soil organic matter under irrigated cropping systems and in rehabilitating former oil and gas well sites. An ongoing project is examining composting economics.

AgTech Centre researchers also maintain contact with the Composting Technology Centre at the Olds College Centre for Innovation. Along with offering a wide range of composting courses, the college also operates the Centre with a network of government and industry partners in agriculture, forestry and oil/gas sectors to find ways to incorporate waste management into daily operations.

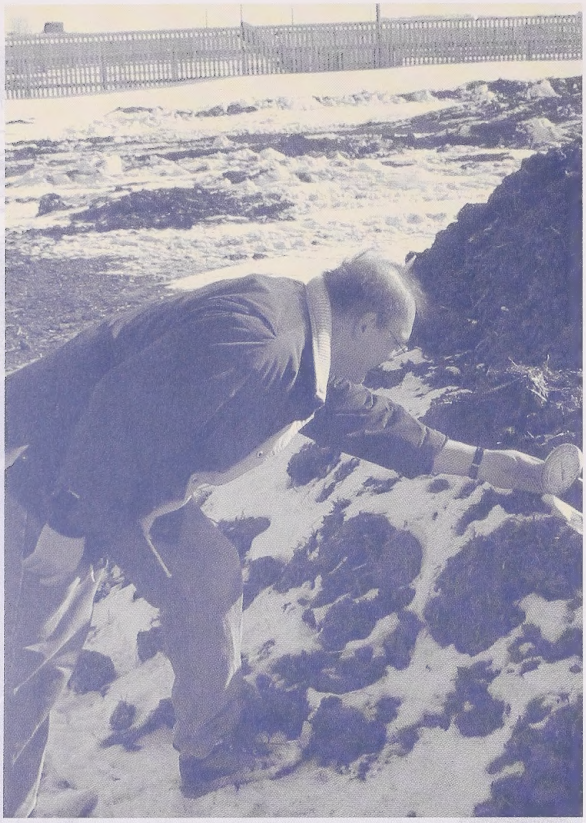
"There is a lot of good information available, but there is still misinformation floating around," says Nelson. "Our goal, through our own research and working with others, is to provide producers with the most current, reliable and useful information on composting technology, as part of practical waste management options."

Reports available

To understand compost, producers need to be clear on the processes at work.

Each research project is ultimately produced in a report format available through the AgTech Centre. The list includes:

- Livestock Mortality Management (Disposal)
- Poultry Mortality Composting
- Swine Mortality Composting
- Large Animal Mortality Composting (pending review)
- Small Animal Mortality Composting with Low Death Loss
- Windrow Mortality Composting of Spent Hens
- Technical Assessment of Physical Compost Aeration Mechanisms and the System Effect on the Mechanical and Biological Efficiency of Composting
- Effects of Moisture Content During Composting of Feedlot Manure



THE CARBON CONNECTION

Carbon drives the compost process.

A proper carbon-to-nitrogen (C:N) ratio, such as straw-to-manure, is key to a proper composting process, explains Virginia Nelson, a composting specialist with the AgTech Centre in Lethbridge.

The ideal is a 25:1 C:N ratio and not more than 30:1. Depending on the manure, it may mean adding more carbon to the mix to achieve the proper ratio. Also, the composting materials initially should be at about 55 percent moisture.

"The combination of materials, moisture and oxygen should produce an ideal composting environment with an internal composting windrow temperature above 50 C," says Nelson. "These are optimum conditions for microbial activity."

While straight manure will compost, the carbon component improves the process, says Nelson.

The C:N ratio is important because if the C:N is lower than 20:1 all available carbon is fully utilized without stabilizing all the nitrogen. The excess nitrogen might then be lost to the atmosphere as ammonia or nitrous oxide, and odour can then become an issue. Composting mixes with higher than 40:1 C:N ratios require longer composting times for the micro-organisms to use the excess carbon.

In the composting process, micro-organisms decompose organic materials progressively, breaking them down from complex to intermediate to simple compounds to obtain nitrogen for new cell material. Some of the nitrogen is converted to ammonia. If the nitrogen becomes available faster than it is used, ammonia accumulates. Eventually this lighter-than-air gas can escape the windrow.

A similar nitrogen loss can also occur in stockpiled manure through denitrification - a process where certain types of bacteria reduce nitrates into nitrite, nitrous oxide, ammonia or elemental nitrogen. Denitrification is responsible for the loss of much of the soil's natural and synthetic fertilizers. The process favours warm, anaerobic conditions found in a manure pile.

"In simple terms, when microbes first become active in compost they digest the easy parts of the nitrogen and let the ammonia pass through them," explains Nelson. "The ammonia will typically bind to the carbon and be held in place. After the microbes complete the first pass, they go back and start working on the more difficult compounds such as the combined carbon and ammonia compounds.

Even with properly composted material there will be some nitrogen loss as some ammonia escapes from the composting pile. But over all, the composting process retains most of the nutrients supplied by the raw materials and stores them within stable organic compounds.

"If you don't have the carbon source to act as a binding agent, much more ammonia is simply lost to the atmosphere," says Nelson. "The composting process is over sooner because the microbes have no food left."

The best way to retain ammonia is to match the rate of nitrogen availability to its rate of uptake by the micro-organisms. The micro-organisms use the nitrogen in proportion to the amount of carbon available. Therefore, high C:N ratios tend to limit ammonia loss.

In properly composted manure, the remaining nitrogen is left in a more organic form, making it much less susceptible to leaching. It is released at a more gradual rate and is more readily available to plants when applied and mixed with the soil.

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